

Wet Detention Basin (No.) Code 1001

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A permanent pool of water with designed dimensions, inlets, outlets and storage capacity, constructed to collect, detain, treat and release stormwater runoff.

II. Purposes - Primary reasons for which the practice is applied. Each purpose identifies a resource problem the practice can be specifically designed to treat.

The primary purposes of this practice are to control water pollution and peak flow.

III. Conditions Where Practice Applies - Land uses and site conditions that affect the suitability or function of the practice.

This practice applies to urban, construction, and agricultural sites where runoff pollution due to suspended solids loading and attached pollutants is a concern. It also applies where increased runoff from urbanization or land use change is a concern. Site conditions must allow for runoff to be directed into the basin and a permanent pool of water to be maintained.

This practice does not apply to wetland restorations, animal lot runoff control, infiltration basins, or dry detention basins. It also does not apply to sites with high concentrations of toxic materials, or other regulated materials contained in the runoff.

This practice may not apply to all flood control, floodplain management and other flooding issues. Modifications to the peak flow criteria or additional analysis of the potential flooding issues may be needed.

IV. Federal, State and Local Laws

The design, construction, and maintenance of wet detention basins shall comply with all federal, state and local laws, rules or regulations. The owner/operator is responsible for securing required permits. This standard

does not contain the text of any federal, state or local laws governing wet detention basins.

The location and use of wet detention basins may be limited by regulations relating to navigable waters (Ch. 30, Stats.), floodplains, wetlands, buildings, wells and other structures, or land uses, such as waste disposal sites and airports. The basin embankment may also be regulated as a dam under Ch. 31 Stats. and further restricted under NR 333, Wis. Adm. Code which includes regulations for embankment heights and storage capacities.

V. Criteria - Allowable limits for design parameters, acceptable installation processes, or performance requirements to accomplish one or more identified purposes.

A. General The following minimum criteria shall apply to all wet detention basin designs used for the purposes stated in section II of this standard. Use more restrictive criteria as needed to fit the conditions found in the site assessment.

1. **Site Assessment** - A site assessment shall be conducted and documented to determine the physical site characteristics that will affect the placement, design, construction, and maintenance of the basin. The site assessment shall identify characteristics such as ground slopes, soil types, soil conditions, *bedrock*¹, sinkholes, drainage patterns, runoff constituents, proximity to regulated structures, natural resources, and specific land uses. The site assessment shall include the following:
 - a. A 2 foot contour map drawn to scale showing location and elevations for the basin area, soil borings and test pits, buildings and other structures, property lines, wells, wetlands, 100 yr.

¹ Words in the standard that are shown in *italics* are described in IX. Definitions. The words are italicized the first time they are used in the text.

- floodplains, surface drains, navigable streams, known drain tile, roads and overhead or buried utilities.
- b. Soil logging of the site shall be to a depth at least 3 ft. below the proposed design bottom of the basin and include information on the texture, color, odor, structure, water table indicators, and distance to and type of bedrock, if encountered.
2. **Water Pollution Control** - A minimum of 80% of the total suspended solids load shall be removed from the runoff volume generated by the drainage area on an average annual basis. The following criteria meet this requirement:
 - a. **Permanent Pool** - All basins shall be designed to include a permanent pool of water consisting of a sediment forebay and main pool. (See fig. 1 and fig. 2)
 - (1) The minimum surface area of the permanent pool shall be based on the total drainage area to the basin or it shall be 10,000 sq. ft., whichever is greater. Table 1 or an *approved model* shall be used. Values shall be prorated for mixed land uses.
 - (2) A sediment forebay shall be located at the inlet to trap large particles such as road sand. The storage volume of the sediment forebay shall be consistent with the maintenance plan, with a goal of 5-15% of the permanent pool surface area. The sediment forebay shall be a minimum depth of 3 ft. plus the depth for sediment storage.
 - (3) The length to width ratio of the flow path shall be maximized with a goal of 3:1 or greater. The flow path is considered the general direction of water flow within the basin including the permanent pool and forebay.
 - (4) A safety shelf shall extend a minimum of 8 ft. from the edge of the permanent pool, with a slope of 10h:1v or flatter. The maximum depth of water over the shelf shall be 1.5 ft.
 - (5) Excluding the safety shelf and sediment storage, the average water depth of the permanent pool shall be a minimum of 3 ft.
 - (6) A minimum of 2 ft. shall be added for sediment storage.
 - (7) For basins greater than 20,000 sq. ft., 50% of the total surface area of the permanent pool shall be a minimum of 5 ft. deep. For basins less than 20,000 sq. ft., maximize the area of 5 ft. depth.
 - (8) All side slopes below the safety shelf shall be 2h:1v or flatter as required to maintain soil stability.

Table 1 - Calculation of Minimum Permanent Pool Surface Area.¹

Land Use/Description/Management ²	Total Impervious (%) ³	Minimum Surface Area of the Permanent Pool (% of Watershed Area)	
Residential			
• < 2.0 units/acre (>1/2 acre lots)	8 - 28		0.7
• 2.0 - 6.0 units/acre	>28 -41		0.8
• > 6.0 units/acre (high density)	>41 - 68		1.0
Office Park/Institutional/Warehouse⁴ (Non-retail related business, multi-storied buildings, usually more lawn/landscaping not heavily traveled, no outdoor storage/manufacturing)	<60 60-80 >80		1.6 1.8 2.0
Commercial/Manufacturing/Storage⁵ (Large heavily used outdoor parking areas, material storage or manufacturing operations)	<60 60-80 >80		1.8 2.1 2.4
Parks/Open Space/Woodland/Cemeteries	0-12		0.6
Highways/Freeways (Includes right-of-way area)			
• Typically grass banks/conveyance	<60		1.4
• Mixture of grass and curb/gutter	60-90		2.1
• Typically curb/gutter conveyance	>90		2.8
Cropland (Cropland that is draining to the basin)			
Dominant Surface Soil Texture ⁶		Erosion < <i>Tolerable</i>	Erosion > Tolerable
- S, LS		0.6	0.9
- SC, SCL, SL, L, SiL, Si		1.6	2.4
- C, CL, SiCL, SiC		2.0	3.0

¹ Multiply the value listed by the watershed area within the category to determine the minimum pond surface area. Prorate for drainage areas with multiple categories due to different land use, management, percent impervious, soil texture, or erosion rates. For example, a 50 acre (residential, 50% imperviousness) x 0.01 (1% of watershed from table) = 0.5 acre + 50 acres (office park, 85% imperviousness) x 0.02 (2% of watershed) = 1.0 acre. Therefore 0.5 acre + 1.0 acre = 1.5 acres for the minimum surface area of the permanent pool.

² For offsite areas draining to the proposed land use, refer to local municipalities for planned land use and possible institutional arrangements as a regional stormwater plan.

³ Impervious surfaces include rooftops, parking lots, roads, and similar hard surfaces, including gravel driveways/parking areas. Roofs are assumed to be pitched and half connected (or draining directly) to the storm sewer system. The other half is assumed to drain onto a vegetated area. Paved parking and storage areas are assumed to be all connected. Sidewalks and driveways are only half connected.

⁴ Category includes insurance offices, government buildings, company headquarters, schools, hospitals, and churches.

⁵ Category includes shopping centers, strip malls, power plants, steel mills, cement plants, lumber yards, auto salvage yards, grain elevators, oil tank farms, coal and salt storage areas, slaughter houses, and other outdoor storage or parking areas.

⁶ S=Sand, Si=Silt, C=Clay, L=Loam (USDA Textural Soil Classification System)

- b. **Extended Detention Volume** - Volume above permanent pool that is released slowly. (see fig. 1 and 2)

- (1) Extended detention volume shall be the runoff volume produced by a 1-yr., 24-hr. design storm or as computed by an approved model. The 1-yr., 24-hr rainfall data for Wisconsin is shown in Table 4. The relationship of runoff to precipitation is shown in Table 5. For curve number determination see Chapter 2, Natural Resources Conservation Service, Technical Release 55 (TR-55). Use the post development curve number.
- (2) Outlet design shall allow for the release of the extended detention volume over a period of 24 hr. or greater.

3. **Peak Flow Control** - Peak flow control shall be designed to maintain stable downstream conveyance systems and comply with local ordinances or conform with regional stormwater plans where they are more restrictive than this standard. At a minimum:

- a. Outflow shall not exceed pre-development peak flows for both the 2-yr. and 10-yr., 24-hr design storms.
- b. All runoff and flow calculations required for peak flow design of this practice shall use a hydrograph-producing method such as TR-55.
- c. When pre-development land cover is cropland, use the runoff curve numbers in Table 2. For all other pre-development land covers, use runoff curve numbers from TR - 55 assuming "good hydrologic conditions." For post-development calculations use runoff curve numbers based on actual conditions.

Table 2 - Maximum Pre-Development Runoff Curve Numbers for Cropland Areas				
Hydrologic Soil Group	A	B	C	D
Runoff Curve Number	55	68	77	80

4. **Inflow Points** – All inlets shall be designed to prevent erosion during peak flows produced by the 10-yr., 24-hr. design storm. Any rock rip-rap or other channel liners shall extend a

minimum of 1.5 vertical ft. below the permanent pool elevation.

5. **Outlets** –All outlet designs shall incorporate preventive measures for ice damage, trash accumulation, and erosion at the outfall.
6. **Emergency Spillway** – All basins shall have an emergency spillway. The spillway shall be designed to safely pass peak flows produced by a 100-yr., 24-hour design storm routed through the basin without damage to the structure. The flow routing calculations shall start at the permanent pool elevation.
7. **Freeboard** – The basin design shall ensure the top of embankment, after settling, is a minimum of 1 vertical foot above the flow depth in the emergency spillway required to safely pass the routed 100-yr., 24-hr. storm.
8. **Side Slopes** – All interior side slopes above the safety shelf shall be 4h:1v or flatter.
9. **Bedrock** – If bedrock is encountered within 2 ft. of the bottom of the pond, special precautions shall be taken, as needed, to minimize movement of pollutants to groundwater.
10. **Earthen Embankments** - Earthen embankments (see fig. 2) shall be designed to address potential risk and structural integrity issues such as seepage and saturation. All constructed earthen embankments shall meet the following criteria.
 - a. The base of the embankment shall be stripped of all vegetation, stumps, topsoil and other matter. Stripping shall be a minimum of 6 in.
 - b. For embankments where the permanent pool is ponded 3 ft. or more against the embankment, there shall be a core trench or key-way along the centerline of the embankment up to the permanent pool elevation. The core trench or key-way shall be a minimum of 2 ft. deep and 8 ft. wide with a side slope of 1:1 or flatter.
 - c. All embankments shall be constructed with non-organic soils and compacted to 90% standard proctor according to the procedures outlined in ASTM D-698 or by using compaction requirements of USDA Natural Resource Conservation Service, Wisconsin Construction Specification 3. No tree stumps, or other organic material shall be buried in the embankment. The constructed embankment height shall be increased by a minimum of 5% to account for settling.

- d. Any pipes extending through the embankment shall be bedded and backfilled with embankment or equivalent soils. The bedding and backfill shall be compacted in lifts and to the same standard as the original embankment. Excavation through a completed embankment shall have a minimum side slope of 1:1 or flatter.
- e. Measures shall be taken to minimize seepage along any conduit buried in the embankment. Measures such as anti-seep collars or sand diaphragms are acceptable.
- f. Downstream side slopes shall be 3h:1v or flatter.
- g. Minimum embankment top width shall be 10 ft.

- 11. **Topsoil and Seeding** - Topsoil shall be spread on all disturbed areas, except for elevations below the safety shelf, as areas are completed. Minimum depth of topsoil spread shall be 4 in. Seed all areas above safety shelf.
- 12. **Operation and Maintenance** - An operation and maintenance plan shall be developed that is consistent with the purposes of this practice, its intended life, safety requirements and the criteria for its design.

The plan shall address the responsible party for operation, maintenance, and documentation of the plan. At a minimum, the plan shall also include details on inspecting sediment depths, frequency of sediment removal, disposal locations for sediment, inlet and outlet maintenance, keeping embankments clear of woody vegetation, and providing access to perform the operation and maintenance activities.

- B. Construction Site.** A wet detention basin, designed to meet the minimum criteria in section V. A. will also meet the criteria for construction sites if the following criteria are followed.

- 1. The minimum permanent pool area shall be the larger of 1.5% of the disturbed area, or the permanent pool size as specified in Table 1.
- 2. If a minimum of 2 vertical feet of sediment storage is not available after construction and site stabilization, all excess sediment must be removed and disposed in accordance with the operation and maintenance plan. After the site is stabilized, the minimum permanent pool depth must meet the requirements of V. A. 2. a.

- C. Agricultural.** A wet detention basin, designed to meet the minimum criteria in V. A. will also meet the criteria for the control of pollution from agricultural watersheds if the following additional criteria and exceptions are followed.

- 1. A permanently vegetated buffer extending a minimum of 75 ft. beyond the designed permanent pool elevation is required around the entire basin.
- 2. The peak outflow for the 10-yr., 24-hr. design storm shall not exceed the peak inflow for the 2-yr., 24-hr. design storm.
- 3. If the permanent pool is ponded 3 ft. or more against the basin embankment, the embankment and spillway design shall meet the criteria in Engineering Standard 378 - Pond, NRCS Field Office Technical Guide (FOTG) Section IV.
- 4. The sediment forebay (V. A. 2. a. (2)) is not required.
- 5. Livestock shall be excluded from the pool, embankment, outlet, and buffer areas.

- VI. Considerations.** Additional recommendations relating to design which may enhance the use of, or avoid problems with, this practice.

- A. General.** Consider the following items for all applications of this standard:

- 1. Additional conservation practices should be considered if the receiving water body is sensitive to temperature fluctuations, oxygen depletion, excess toxins or nutrients.
- 2. Consider providing additional length to the safety shelf, above or below the wet pool elevation, to enhance safety.
- 3. The use of liners should be evaluated for maintaining permanent pool levels and reducing potential groundwater contamination.
- 4. To prevent damage or failure due to ice, all risers extending above the pond surface should be incorporated into the basin embankment.
- 5. The use of underwater outlets should be considered to minimize ice damage, accumulation of floating trash or vortex control.

6. When designing basins in series (along same flow path), consider the impacts on sediment removal efficiency, flow routing, and safety.
7. Minimum watershed size and land cover should be considered to ensure adequate runoff volumes to maintain a permanent pool. For supplementing low runoff periods, consider the installation of a well to maintain the permanent pool level.
8. Aesthetics of the pond should be considered in designing the shape and specifying landscape practices.
9. If downstream flood management or bank erosion is a concern, a watershed study should be conducted to determine the most appropriate location and design of stormwater management structures.
10. For elongated pools in the direction of prevailing winds, consider reinforcing banks, extending the safety shelf, or other measures to prevent erosion of embankment due to wave action.
11. Consider the potential impacts on downstream channels, farming practices, or other land uses if the wet detention basin may create or alter base flows.
12. To prevent failure, earthen emergency spillways should not be constructed over fill material.
13. All flow channels draining to the basin should be stable to minimize sediment delivery to the basin.
14. The use of baffles may be used to artificially lengthen the flow path in the basin.
15. Consider aerators to maintain aerobic conditions.

B. Urban Applications. Consider the following items when applying this standard to urban areas:

1. Consider including volume reduction practices in the design to reduce the potential downstream impacts of larger runoff volumes with increased development.
2. Consider using flow splitters before the basin inlet to provide treatment of the first flush from urban areas.

3. Consider safety issues such as signage, flotation devices and special landscaping to deter entry by people.
4. Consider the effects of construction site compaction and the use of deep tilling to increase soil infiltration. Consider raising the hydrologic soil group used in calculating post-development runoff to calculate a more representative runoff volume due to compaction.
5. Consider vegetative buffer strips along drainage ways leading to the detention basin to help filter pollutants in urban runoff.

C. Construction Site Applications. Consider the following items when applying this standard to construction sites:

1. Consider providing extra sediment storage depth for structures that will serve as permanent stormwater management practices. This could eliminate the need for sediment removal after site stabilization.
2. The entire drainage area, and all of the basin side slopes, should be thoroughly stabilized with a vegetative cover prior to conversion to a permanent pond.
3. Consider construction sequencing to minimize the amount of land opening during construction.

D. Agricultural Applications. Consider the following items when applying this standard to an agricultural setting:

1. Consider installing a sediment forebay to minimize maintenance needs for the entire basin, especially if coarse surface soils are present in the watershed.
2. Consider vegetative buffer strips between cropland and drainage ways leading to the detention basin to help filter agricultural pollutants. See Standard 393 - Riparian Vegetative Buffer, NRCS FOTG Section IV.
3. To enhance use by wildlife, consider enlarging the pond surface area, flattening slopes below the water surface, creating irregular edges and planting native species in and around the pond. See Chapter 11 - Ponds and Reservoirs, NRCS Engineering Field Manual.

4. Consider using the basin as an outfall for subsurface drains from upstream agricultural lands.
5. All concentrated flow channels entering the basin from drainage areas as large or larger than those listed in the middle column of Table 3 should be vegetated adequately to carry the 10 yr. storm. See Standard 412 - Grassed Waterway, NRCS FOTG Section IV and to Chapter 7 - Grassed Waterways, USDA-NRCS Engineering Field Manual.
6. All concentrated flow channels entering the basin from drainage areas in the range shown in the right hand column of Table 3 should be vegetated 200 ft. up the channel from the permanent pool. Vegetation should be adequate to carry the 10 yr. storm.
7. Consider measures to minimize sheet and rill erosion in the entire drainage area.

Table 3 - Drainage areas for vegetation of concentrated flow channels		
Hydrologic Soil Group	Drainage Area for vegetated channels, ac	Drainage Area for 200 ft. of vegetation up the channels, ac
A	100	20 to 99
A/B	40	15 to 39
B	25	10 to 24
B/C	15	7 to 14
C, D	10	5 to 9

- E. Operation and Maintenance Considerations for All Applications** -The maintenance plan should address weed or algae growth and removal, insect and wildlife control and any landscaping practices. Outlet designs should consider having the ability to dewater the pond to ease future maintenance. To prevent nuisance from geese, consider not mowing around the pond perimeter. To maximize safety and pollutant removal, allow plant growth along the safety shelf.

VII. Plans and Specifications

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use. Plans shall specify the materials, construction processes, location, size and elevations of

all components of the practice to allow for certification of construction upon completion.

VIII. References

- Center for Watershed Protection, *Stormwater BMP Design Supplement for Cold Climates*, Draft Review Document, August 1997.
- United States Department of Agriculture, Natural Resources Conservation Service, *Ponds – planning, Design, Construction*, Agriculture Handbook 590, Revised September 1997.
- United States Department of Agriculture - Natural Resources Conservation Service, *Wisconsin Field Office Technical Guide, Section IV*.
- United States Department of Agriculture - Natural Resources Conservation Service, *Engineering Field Handbook*.
- United States Department of Agriculture - Natural Resources Conservation Service, *Technical Release 55*.
- United States Department of Commerce - Weather Bureau, *Rainfall Frequency Atlas of the United States, Technical Paper 40*.
- Wisconsin Department of Natural Resources - Bureau of Water Resources Management, *Wisconsin Construction Site Best Management Practice Handbook*, Publication WP-222 93 REV, April 1994.
- Wisconsin Department of Natural Resources - Bureau of Water Resources Management, *The Wisconsin Stormwater Manual Part One: Overview*, Publication WR-349-94.

IX. Definitions

Approved Model(V. A. 2. b. (1), V. A. 2. c. (1)) - A computer model that is used to predict pollutant loads from urban lands and has been approved by the applicable regulatory authorities. SLAMM and P8 are examples of models which may be used to verify that a detention pond design meets the minimum criterion of 80% reduction of suspended solids.

Bedrock (V. A. 1., V. A. 1. b., V. A. 2. a.) - Consolidated rock material and weathered in-place material with > 50%, by volume, larger than 2 mm in size.

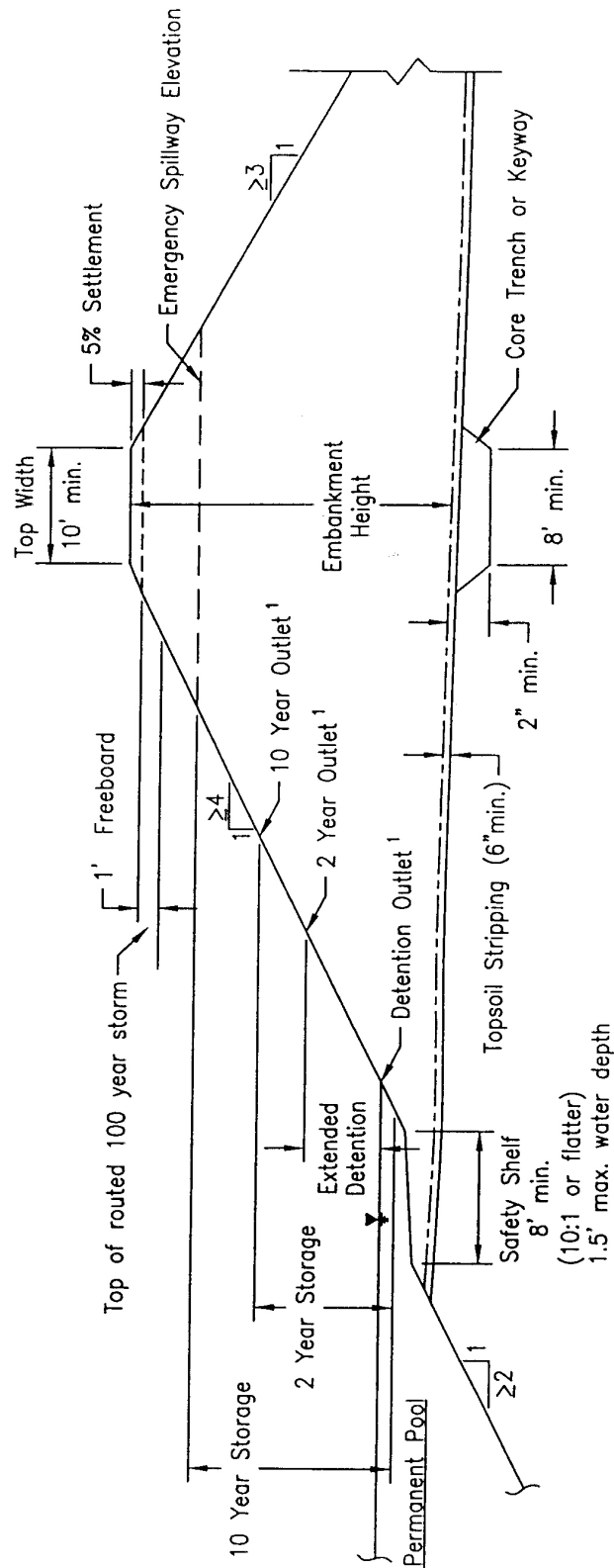
Tolerable (Table 1) - The tolerable level ("T") of erosion that could occur without losing long term productivity as farmland. T values are assigned for each soil type and are found in Section 1 of the NRCS FOTG. Erosion

rates are estimated using industry standard formulas such as the Revised Universal Soil Loss Equation.

Table 4 - Rainfall for Wisconsin Counties for a 1 - year, 24 - hour Rainfall¹	
Inches of Rainfall	County
2.1 in.	Door, Florence, Forest, Kewaunee, Marinette, Oconto, Vilas
2.2 in.	Ashland, Bayfield, Brown, Calumet, Douglas, Iron, Langlade, Lincoln, Manitowoc, Menominee, Oneida, Outagamie, Price, Shawano, Sheboygan
2.3 in.	Barron, Burnett, Dodge, Fond du Lac, Green Lake, Marathon, Milwaukee, Ozaukee, Portage, Racine, Rusk, Sawyer, Taylor, Washburn, Washington, Waukesha, Waupaca, Waushara, Winnebago, Wood
2.4 in.	Adams, Chippewa, Clark, Columbia, Dane, Dunn, Eau Claire, Jackson, Jefferson, Juneau, Kenosha, Marquette, Pepin, Pierce, Polk, Rock, St. Croix, Walworth
2.5 in.	Buffalo, Green, Iowa, La Crosse, Monroe, Richland, Sauk, Trempealeau, Vernon
2.6 in.	Crawford, Grant, Lafayette
¹ TP - 40 - Rainfall Frequency Atlas of the United States, U.S. Department of Commerce Weather Bureau.	

Table 5 - Runoff for Selected Curve Numbers and Rainfall Amounts¹											
Rainfall (inches)	Runoff Depth in Inches for Curve Number of:										
	50	55	60	65	70	75	80	85	90	95	98
2.1 in.	.00	.02	.08	.17	.28	.43	.63	.88	1.18	1.58	1.87
2.2 in.	.01	.04	.10	.20	.33	.49	.69	.95	1.27	1.67	1.97
2.3 in.	.01	.06	.13	.24	.37	.54	.76	1.03	1.35	1.77	2.07
2.4 in.	.02	.07	.15	.27	.42	.60	.82	1.10	1.44	1.86	2.17
2.5 in.	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
2.6 in.	.03	.10	.20	.34	.51	.71	.96	1.26	1.62	2.06	2.37
¹ NRCS TR-55											

Figure 2: Typical Embankment Cross Section for Wet Detention Basin
(Not to Scale)



1. These are conceptual outlet locations to indicate the need to have different outlets for different purposes. Numerous outlet designs will meet the criteria of the standard.

Figure 1: Conceptual Wet Detention Basin
(Not to Scale)

